Description

Method for transmit power compensation in a mobile communication terminal, and a communication terminal for implementing said method

The invention relates to a method for transmission power adjustments for a mobile communications terminal, which is equipped with a power amplifier whose output signal amplitude depends on the frequency of an input signal to the power amplifier, an RF connector, an internal antenna and a connection for an external antenna, and which is designed for operation in at least one standard mobile radio frequency band. The invention also relates to a communications terminal by means of which the method for transmission power adjustment can be carried out.

In order to set up a communication link by means of mobile radio terminals as an example of mobile communications terminals, it is necessary for the electromagnetic waves to be transmitted via antennas to the communications terminals. The electromagnetic fields which are involved for the transmission of electromagnetic waves also penetrate into human tissue, for example in the situation when a user of a communications terminal is holding the terminal against his ear. This leads to a thermal load on the human tissue, which must be kept within permissible limits. One measure for assessment of the thermal load is the so-called "SAR value", with the abbreviation "SAR" standing for specific absorption rate. Appropriate

limit values are specified in standards, such as EN 50361, IEEE Std 1528-200X.

Since the dimensions of mobile communications terminals are becoming ever smaller, the power emission is concentrated over an ever narrower band, so that this

can also result in an increased thermal load on the user in particular when the communications terminal is used for this purpose.

In detail, this results in areas of maximum thermal load (hot spots), which determine the SAR value.

Until now, the main way to reduce the SAR value has been to insert radiation-absorbent components, such as an absorber sheet, in the communications terminals. Alternatively, the dimensions of the mobile communications terminals can also be enlarged, although this influences the design of the terminals.

By way of example, the GSM specification stipulates what minimum RF output power must be available at an RF connector of a mobile communications terminal which not only has an internal antenna but is also designed for connection via the RF connector to an external antenna. In this context, it is important that the output signal amplitude of a power amplifier for a mobile communications terminal depends on the frequency of the input signal to the power amplifier, that is to say the antenna output power from the mobile communications terminal is frequency-dependent and channel-dependent. In order now to satisfy the requirements from the GSM specification which has been mentioned here by way of example, adjustments have until now been made to the channel with the lowest power, so that it is possible to assume that all the channels satisfy the minimum GSM-specific power. This procedure leads to the SAR value being particularly high, for example for the channels located in the center of the frequency

spectrum, assuming a typical profile for the frequency dependence of the emitted power.

In contrast, it has not yet been possible until now to consider the possibility of power adjustment deliberately in order to optimize the SAR value.

Against this background, the invention is based on the object of specifying a method for power adjustment for a mobile communications terminal, in which the SAR value can be effectively optimized. A further aim is to provide a communications terminal for carrying out the method.

The object mentioned above is achieved with regard to the method by a method for transmission power adjustments for a mobile communications terminal, which is equipped with a power amplifier whose output signal amplitude depends on the frequency of an input signal to the power amplifier, an RF connector, an internal antenna and a connection for an external antenna, and which is designed for operation in at least one standard mobile radio frequency band, in which case the at least one standard mobile radio frequency band is subdivided into two or more frequency intervals, and one power adjustment operation is carried out in each case for at least some of the frequency intervals.

According to the new method, this means that, in contrast to the previous situation, in which power adjustment can be carried out only for the entire frequency band, power adjustment is additionally carried out on a frequency-interval specific basis. The frequency intervals may have the same constant width, or a varying width.

This makes it possible likewise to adjust the power particularly for the central frequency intervals, which in fact makes it possible to reduce the SAR value of the central frequency intervals, and thus to optimize it.

In this case, the power adjustment can be carried out either for all the frequency intervals into which the standard mobile radio frequency band is subdivided, or else, for example, only for a number of frequency intervals, for which the emitted power from the antenna is particularly high, owing to the frequency dependency of the antenna. This makes it possible to simultaneously satisfy not only any specifications for a mobile radio standard but also the requirements for an SAR value that is as low as possible.

The power adjustment for the frequency intervals can be carried out by access to a reference table, in which an adjustment factor is associated with each frequency interval. These adjustment factors reflect the frequency profile on the power amplifier and, if appropriate the antenna characteristics, that is to say the entries in the reference table may correspond to the reciprocal of a normalized frequency profile of the power amplifier. This makes it possible to reduce the SAR value for the given frequency interval at that time.

The power adjustment for the RF connector is preferably carried out as a function of whether the mobile communications terminal is operated with its own internal antenna or with an external antenna. In the latter case, a reference table can be provided which ensures that an input signal whose amplitude is independent of frequency is produced at an input to the RF connector. The appropriate specifications are taken into account in this case.

It is preferably possible to use an antenna detector to determine whether the mobile communications terminal is operating with its own internal antenna or with an external antenna, with the antenna detector responding, for example, when the internal antenna is being used,

thus resulting in a situation in which the SAR value is of particular importance.

In one preferred embodiment of the method, the power adjustment when using the internal antenna can be carried out such that the emitted power level from the mobile communications terminal is essentially independent of the frequency of the input signal to the power amplifier. This means that the output power from a transmission antenna for the mobile communications terminal is independent of frequency. This has the advantage that, for example, weak channels at the edge of the standard mobile radio frequency band have their power increased, to produce an improved communication link for an uplink connection to a base station.

The power is adjusted in a particularly advantageous manner by giving priority to the optimization of the SAR value over the at least one standard mobile radio frequency band.

It should be stressed that the method can, of course, also be carried out for transmission power adjustment for a mobile communications terminal which can operate in two or more standard mobile radio frequency bands. In this case, two or more reference tables, for example, are provided, and are used in the manner described above.

The object as mentioned above is achieved with regard to the communications terminal by a mobile communications terminal having a power amplifier whose output signal amplitude depends on the frequency of the input signal to the power amplifier, and having a

device for power adjustment for the output power from the communications terminal in at least one standard mobile radio frequency band, in which case the device for power adjustment is designed to adjust the

output power for two or more frequency intervals in the at least one standard mobile radio frequency band.

Preferred embodiments of the communications terminal can be found in the dependent claims 7 to 9.

The major features of the communications terminal are that the required means for respective power adjustment are provided for individual frequency intervals in a standard mobile radio frequency band. These means may be the already described reference table. The use of an antenna detector allows different reference tables to be used for power adjustment for different operating conditions of the mobile communications terminal, with the operating conditions being distinguished on the basis of whether the antenna is external or internal.

It should be mentioned that the software-implemented solution in which a reference table is used will undoubtedly be the more cost-effective, and is thus preferred overall.

Exemplary embodiments of the invention will be described in the following text with reference to the drawings, in which:

Figure 1 shows the typical frequency profile of the emitted power from an antenna for a mobile communications terminal with a standard input signal amplitude;

Figure 2 shows a schematic block diagram of a transmission output stage of a mobile communications terminal, by means of which

power adjustment can be carried out for individual frequency intervals, and

Figure 3 shows an example of a reference table for a triband communications terminal.

As can be seen from Figure 1, the output power I of an antenna AI is dependent on frequency, assuming that the input signal amplitude to the power amplifier remains constant. By way of example, Figure 1 shows a total of six frequency intervals, which each indicate different mean output power levels, with the frequency interval 4 containing the power maximum. Power adjustment is carried out individually for each of the frequency intervals 1 to 6. This power adjustment is carried out such that an SAR value which is as constant as possible is set for all of the frequency intervals 1 to 6.

The frequency profile, which results after the power adjustment, for the amplitude of the output signal from the power amplifier PA is likewise illustrated in Figure 1, to be precise by means of a dashed-dotted line. This clearly shows that the power adjustment results in an increase in the power for the frequency intervals or mobile radio channels 1 and 6, which are obviously weak, so that they have a better signal-to-noise ratio when used in an uplink connection to a base station in a mobile radio network.

The separate power adjustment for all six frequency intervals furthermore means that the power that is emitted from an antenna A and is in principle based on the amplitude of the output signal from the power amplifier PA is reduced for particularly strong channels, such as the channels or frequency intervals 3 and 4 in this case, thus resulting in a reduction in

the associated SAR value. In comparison to the prior art, this results in a reduction in the SAR value for the strongest channels or frequency intervals on which the mobile communications terminal is operating.

For the weak frequency intervals 1 and 6, the power can be increased until the associated SAR value is slightly below a predetermined maximum SAR value, with a value range (which is predetermined by the relevant mobile radio specification) for the channel power being taken into account as a boundary condition. Overall, this results in a more uniform power capability for the mobile communications terminal over the mobile radio frequency spectrum on which it is being used at that time.

Figure 2 shows one embodiment of a method for carrying out the power adjustment.

An output signal from the power amplifier PA is passed to an RF connector K, whose output signal is supplied to an internal antenna AI. In the embodiment shown in Figure 2, the antenna AI is connected to an antenna detector D, which continuously emits the power that is emitted from the antenna AI. When the antenna detector D detects that the mobile terminal is operating in an operating state with the internal antenna AI, it will send a signal to a reference table V2. The reference table V2 selects frequency-dependent power adjustment. Values for the RF connector K are stored in a reference table V1.

The reference table V2 is accessed when the antenna detector D detects that the internal antenna AI for the mobile communications terminal is being used, whose radiated power is critical with respect to an SAR value. The reference table V1 contains adjustment values for the power amplifier PA which, in the end,

lead to the emitted power from the communications terminal being essentially constant over the standard mobile radio spectrum that is being used at that time.

If, in contrast, the antenna detector D finds that an external antenna AE, which is likewise connected to the RF connector via a suitable connection, is being used, the reference table V1 is accessed, whose adjustment values are designed such that they ensure that the RF power which is provided by the power amplifier PA at an input to the RF connector is independent of frequency.

The adjustment factors in the reference table V2 are chosen such that the SAR value is slightly below the predetermined maximum SAR value for all of the frequency intervals. The adjustment factors that are required for this purpose may be determined empirically.

Figure 3 shows one example of the reference table V2, with the reference table V showing a total of three standard mobile radio frequency bands, that is to say GSM 900, DCS 1800 and PCS 1900. Each of these frequency bands is subdivided into a total of ten groups, with the start frequency, the end frequency, the difference frequency between the end frequency and the start frequency and the center frequency being specified for each group. Each individual group in the reference table V2 has an associated adjustment value, which is obtained empirically, for example as a function of characteristics of the power amplifier and of the antenna, or of further circuit elements.